Revision History

Date	Sheet (New)	Item	Old	New	Reason
'01-10-29	NEW				

Caution and Handling Precaution

For your end user's safety, it is strongly advised that the items with"∗"should be included in the instruction manual of the system which may be issued by your organization.

For Safety

⚠ Warning

(1) Toshiba's Standard LCD modules have not been customized for operation in extreme environments or for use in applications where performance failures could be life-threatening or otherwise catastrophic.

Since they must never be installed in aircraft navigation control systems (such as, but not limited to Traffic Collision System and Air traffic Indicator), in military defense or weapons systems, in critical industrial process-control systems (e.g., those involved in the production of nuclear energy), or in critical medical device or patient life-support systems.

(2) DISCONNECT POWER SUPPLY before handling LCD module.

DO NOT TOUCH the parts inside LCD module and the fluorescent lamp's (hereinafter called "FL") connector or cable in order to prevent electric shock, because high voltage is supplied to these parts from the inverter unit while power supply is turned on.

(3) Make sure to insert the module FL connector to the inverter connector in correct position.

Do not insert in irregular position.

If incorrect, this may cause smoke or burn of electrical parts by high voltage of FL circuit.

If there is a possibility that the connector has been inserted incorrectly, please re-insert the connector only after you confirm the module and FL power is completely off.

DO NOT USE the mating FL connector which Toshiba does not specify.

Otherwise, Toshiba shall not be liable for any damages caused by the connector.

⚠ Caution

(1) DO NOT DISASSEMBLE OR MODIFY the module.

Sensitive parts inside LCD module may be damaged, and dusts or scratches may mar the displays.

Toshiba does not warrant the modules, if customer disassembled or modified them.

∗(2) DO NOT INGEST liquid crystal material, DO NOT INHALE this material, and DO NOT PERMIT this material to contact the skin, if LCD panel is broken and liquid crystal material spills out.

In the event of inadvertent contact, immediately rinse the mouth or eyes with adequate water. If this material should inadvertently contact the skin or clothing, wash immediately with alcohol and then rinse thoroughly with water.

∗(3) BE CAREFUL WITH CHIPS OF GLASS that may cause injuring fingers or skin, when the glass is broken.

(4) DO NOT EXCEED the absolute maximum rating values under the worst probable conditions caused by the supply voltage variation, input voltage variation, variation in parts' constants, ambient temperature, etc., otherwise LCD module may be damaged.

(5) Suitable protection circuit should be applied for each system design.

DO NOT MODIFY the fuse used in the module. It may cause overheat and/or burning if dusts or metal particles are on the PCBs in the LCD module.

(6)   Be sure that power supply output from the system should be limited to smaller values than listed shown below. (For example Quick Arcing Fuse with listed ratings can be used.)

It is because this LCD module explained in this specification has a current limiter, with such function at power input line(s). But it may be some possibility of overheat and/or burning of LCD module and its peripheral devices before current limiter of the module when open-short test of the module is performed by using power supply higher than following recommended value.

Power Supply	Recommended maximum Output current of Power supply	Recommended Fuse Rating (In case of using fuse For current limiter)	Built-in Fuse Rating (For reference)
V_{DD}	4.0 A	1.0 A	1.0 A

(7)   Always comply with all applicable environmental regulations, when disposing of LCD.

For Designing the System

(1)   LCD module should be assembled to the system by using all mounting holes specified in this specification and with the specified screws.

(2)   Power supply lines should be designed as follows.

Power supplies should always be turned on before the input signals are supplied to LCD module, and the input signals should be disconnected before power supplies are turned off.

If the sequence does not satisfy specified conditions, it may cause miss-operation of the panel.

Refer to "2.4.2 Sequence of Power Supplies and Signals" for the detailed specification.

(3)   DO NOT GIVE high voltage to "Low Voltage" side of the FL.

For example, DO NOT USE a floating inverter which gives high voltage to "Low Voltage" side. That's because it has a possibility to burn or smoke around the FL.

(4)   Make sure to connect correctly high-voltage wire and low-voltage wire between FL tube and inverter unit.

(5)   Input FL starting voltage (V_{SFL}) should not be less than one second.

If it were less than one second, it may cause unstable operation of FL.

Please adjust inverter circuit parameters, such as capacitor, resistor, to assure the display quality is maintained.

There is a possibility that flicker is observed by the interference of LCD operating signal timing and FL driving condition (especially driving frequency).

(6)   In case of severe environmental condition like outdoor usage, a proper transparent protective cover (lens) over LCD module is recommended to apply in order to prevent scratches, and invasion of dust, water, etc., from the system's window onto LCD module.

Ultra-violet ray cut filter is recommended to apply onto LCD module for outdoor operation. Strong ultra-violet ray may cause damage the panel.

(7)   Design the system not to display same pattern for a long time in order to prevent image sticking on the panel. Note that incorrect sequence of power supplies and input signals may cause the sticking on the panel, too.

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←# Special   ←& Addition   ← Change

For Installation in Assembly

(1) The C-MOS LSIs used in LCD module are very sensitive to ESD (Electro-static Discharge).

Ambient humidity of working area is recommended to be higher than 50%(RH).

Person handling LCD modules should be grounded with wrist band. Tools like soldering iron and screw driver, and working benches should be grounded.

The grounding should be done through a resistor of 0.5-1Mohms in order to prevent spark of ESD.

(2) When remove protection film from LCD panel, peer off the film slowly (more than three seconds) from the edge of the panel, using a soft-pointed tweezers covered by teflon or adherent tape.

(3) Reduce dust level in working area. Especially the level of metal particle should be decreased.

Use finger stalls or soft and dust-free gloves in order to keep clean appearance of LCD module when handled for incoming inspection and assembly.

∗(4) When LCD panel becomes dirty, wipe off the panel surface softly with absorbent cotton or another soft cloth.

If necessary, breathe upon the panel surface and then wipe off immediately and softly again.

If the dirt can not be wiped off, absorbent cotton wetted a little with normal-hexane or petroleum benzine can be used for wiping the panel.

Be careful not to spill this solvent into the inside of LCD module. Driver ICs and PCB area used inside LCD module may be damaged by the solvent.

∗(5) AVOID THE CONDENSATION OF WATER

Wipe off a spot or spots of water of mist and chemicals of mist on LCD panel softly with absorbent cotton or another cloth as soon as possible if happened, otherwise discoloration or stain may be caused. If water invade into LCD module, it may cause LCD module damages.

∗(6) Do not expose LCD module to the gas (which is not normally contained in the atmosphere), it may cause mis-operation or defects.

∗(7) DO NOT APPLY MECHANICAL FORCES.

Do not bend or twist LCD module even momentary when LCD module is installed an enclosure of the system. Bending or twisting LCD module may cause its damages.

Make sure to design the enclosure that bending/twisting forces are not applied to LCD module when it is installed in the system.

Refrain from strong mechanical shock like dropping from the working bench or knocking against hard object.

These may cause glass of the panel crack, damage of FL or other mis-operation.

∗(8) Refrain from excessive force like pushing the surface of LCD panel. This may cause damage of the panel or electrical parts on PCB.

∗(9) Do not put heavy object such as tools, books, etc., and do not pile up LCD modules.

Be careful not to touch surface of the polarizer laminated to the panel with any hard and sharp object. The polarizer is so soft that it can easily scratched, even the protect film covers it.

(10) When inserting or disconnecting the connectors to LCD module, be sure not to apply force against PCB, nor connecting cables, otherwise internal connection of PCB and TAB drivers may be damaged.

Do not fasten screws while putting cables like those for interface or FL between LCD module and the enclosure.

Make sure to insert the module FL connector to the inverter connector in correct position.

If incorrect, this may cause smoke or burn of electrical parts by high voltage of FL circuit.

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(11)　Be careful not to pull the FL cables of the backlight in order to avoid mechanical damage in FL lamp and soldering area.
Be careful not to pull or not to hurt the FPC (Flexible Printed Circuit) cables.

(12)　Power supplies should always be turned off in assembling process.
Do not connect or disconnect the power cables and connectors with power applied to LCD module. This may cause damage of module circuit.
The signal should be applied after power are turned on. And the signal should be removed before power supplies are turned off. (Refer to "For Designing The System"(2).)

(13)　In case of LCD long period operation, discoloration of light guide or optical sheet will be happened due to ultra violet and heat from CCFL.　　As the result, there is possibility to have out of specification for the optical characteristics as "5.2".　　But this is not irregular phenomena.
Moreover, CCFL also has the characteristic of color shift by long period operation.

For Transportation and Storage

(1)　Do not store LCD module in high temperature, especially in high humidity for a long time (approximately more than one month).
It is recommended to store LCD module where the temperature is in the range of 0 to 35 ℃ and the relative humidity is lower than 70%.

(2)　Store LCD module without exposure to direct sunlight or fluorescent lamps in order to prevent the module from strong ultra violet ray.

＊(3)　Avoid condensation of water on LCD module, otherwise it may cause miss-operation or defects. Keep away LCD module from such ambient.

(4)　In case of transportation of storage after opening the original packing. LCD module are recommended to be repacked into the original packaging with the same method, especially with same kind of desiccant.

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←# Special   ←& Addition   ← Change

1. Scope

This specification is applicable to Toshiba's 38cm diagonal size TFT-LCD module "LTM15C458" designed for Monitor.

2. Product Specifications

2.1 General Specifications

Item	Specifications
Display Mode	TN color (253 gray scales, 16,194,277 colors Transmissive type, Normally white
Viewing Direction	6 o'clock (in direction of maximum contrast)
Driving Method	TFT active matrix

Input Signals	LVDS interface
	  RXCLK+, RXCLK, RXIN0+, RXIN0-, RXIN1+, RXIN1-,
	  RXIN2+, RXIN2-, RXIN3+, RXIN3-,

Dimensional Outline	331.6 (W) × 255 (H) × 13.0 max. (D) (mm)
Active Area	304.128 (W) × 228.096 (H) (mm)
Viewing Area	307.2 (W) × 231.2 (H) (mm)
Number of Pixels	1024 (W) × 768 (H) [1]
Pixel Pitch	0.297 (W) × 0.297 (H) (mm) [1]
Pixel Arrangement	RGB vertical stripes [1]
Surface Treatment	Anti-glare and hard coat 3H on LCD surface
Backlight	4 cold-cathode fluorescent lamps for sidelighting

Note 1) Display area address is as follows.
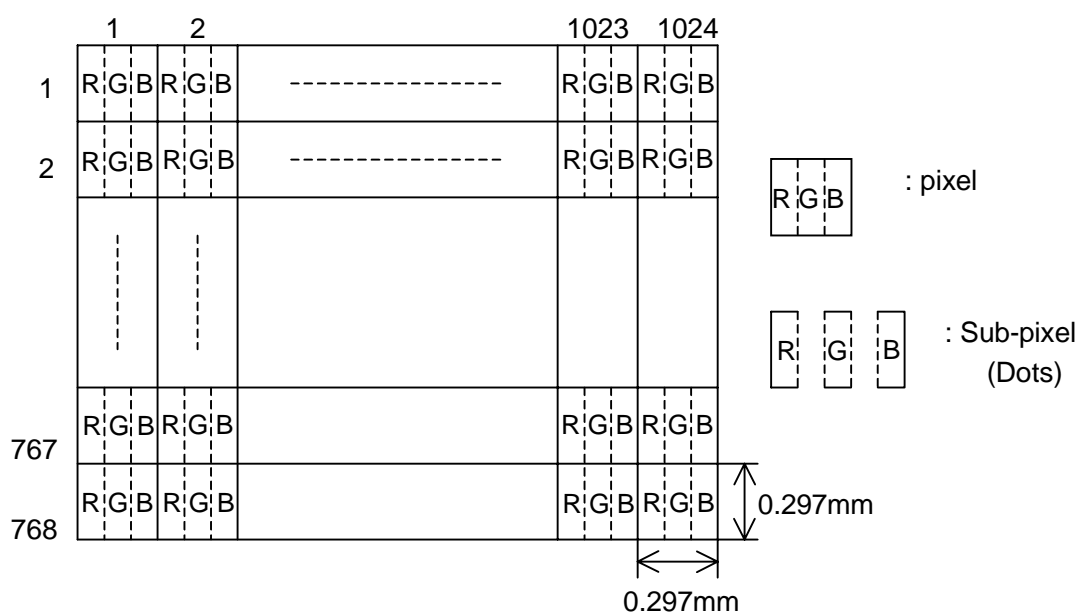
2.2 Absolute Maximum Ratings [1]

Item	Symbol	Min.	Max.	Unit	Checked Terminal [4]
Supply Voltage	V_{DD}	-0.3	+4.0	V	V_{DD} - GND
Input Voltage of Signals	V_{IN}	-0.3	V_{DD}+0.3	V	LVDS interface
FL Driving Voltage	V_{FL}	0	2.0	kV(rms)	
FL Driving Frequency	f_{FL}	0	100	kHz	
Operating Ambient Temperature [2]	T_{OP}	0	+50	°C	
Operating Ambient Humidity [2]	H_{OP}	10	90	%(RH)	
Storage Temperature [2]	T_{STG}	-20	+60	°C	
Storage Humidity [2]	H_{STG}	10	90	%(RH)	
Operating Temperature for Panel [3]	-	0	+60	°C	

Note 1) Do not exceed the maximum rating values under the worst probable conditions taking into account the supply voltage variation, input voltage variation, variation in part constants, and ambient temperature and so on. Otherwise the module may be damaged.

2) Wet bulb temperature should be 39°C (Max), and no condensation of water. See figure below.

3) The surface temperature caused by self heat radiation of cell itself is specified on this item.

4) Refer to 2.4.5
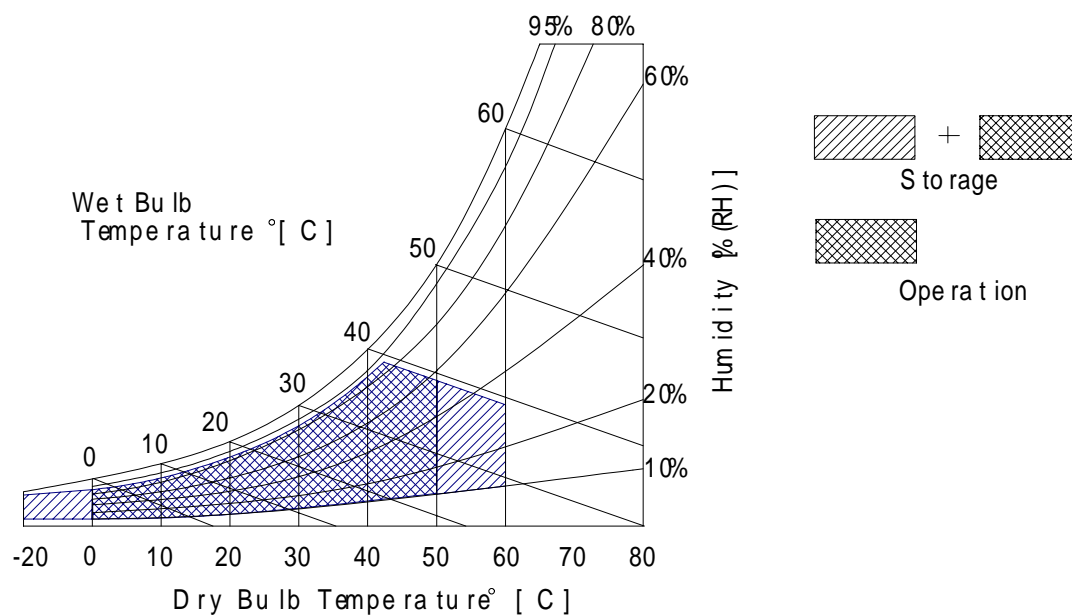
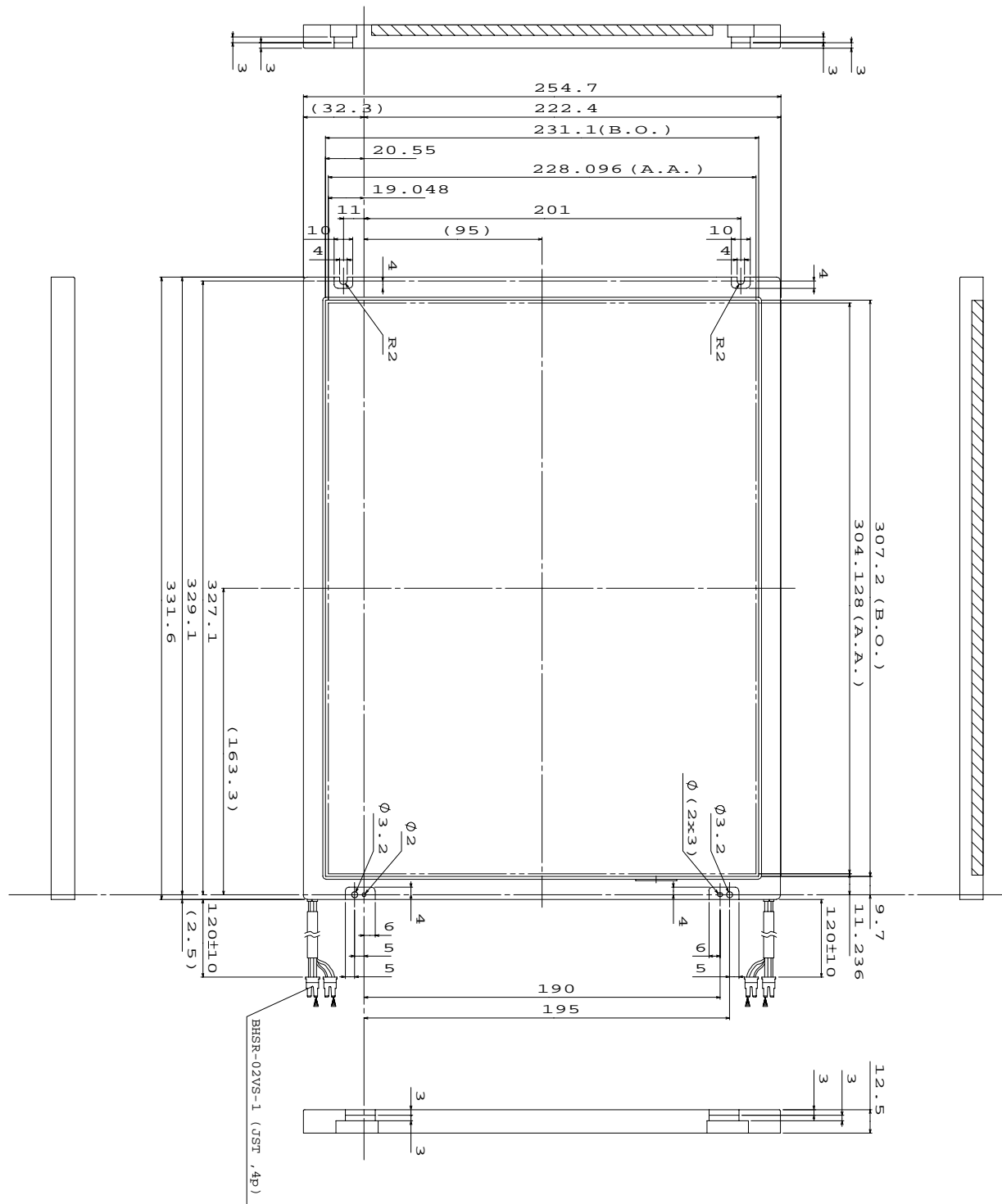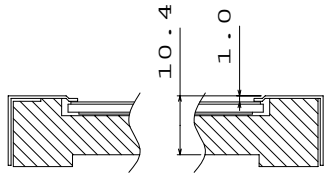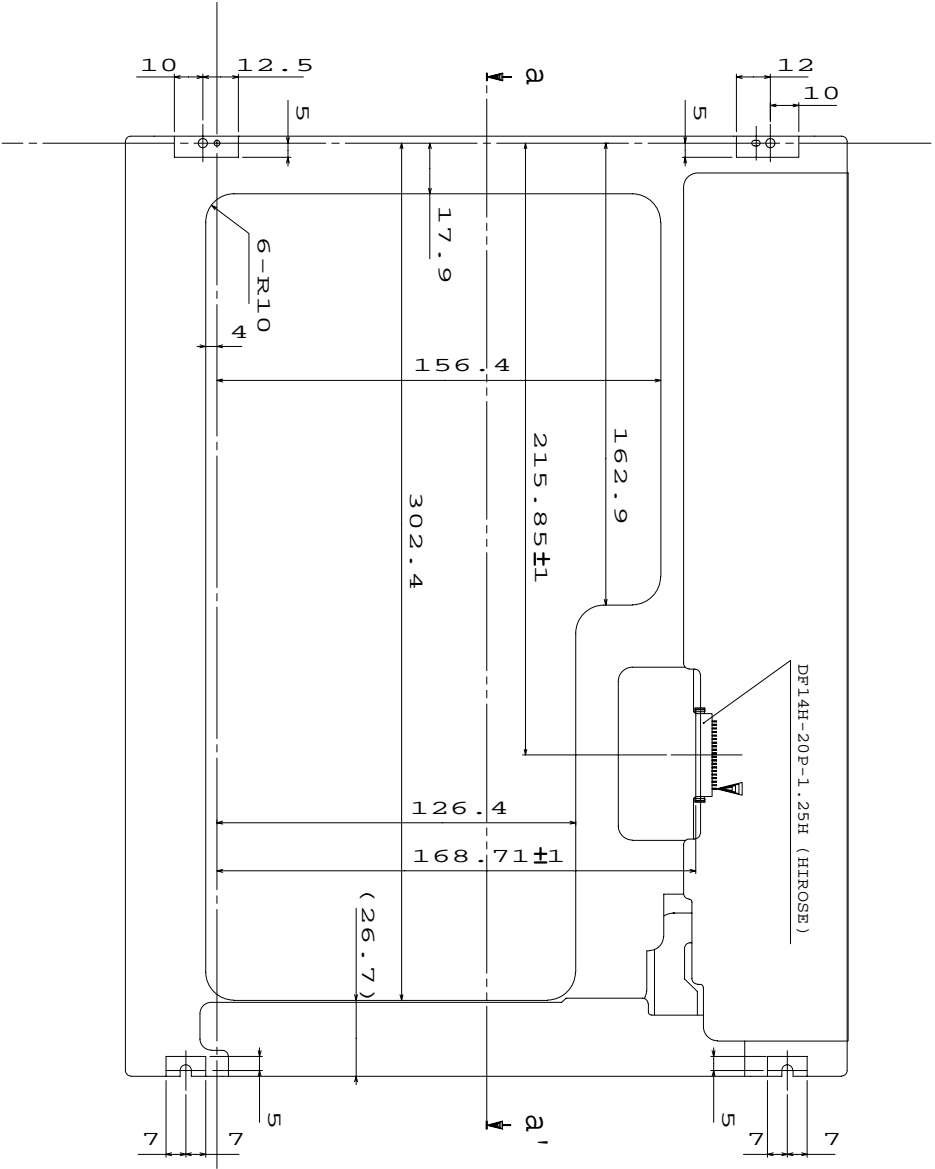## 2.3 Mechanical Specifications
2.3.1 Weight

1200 ± 50g

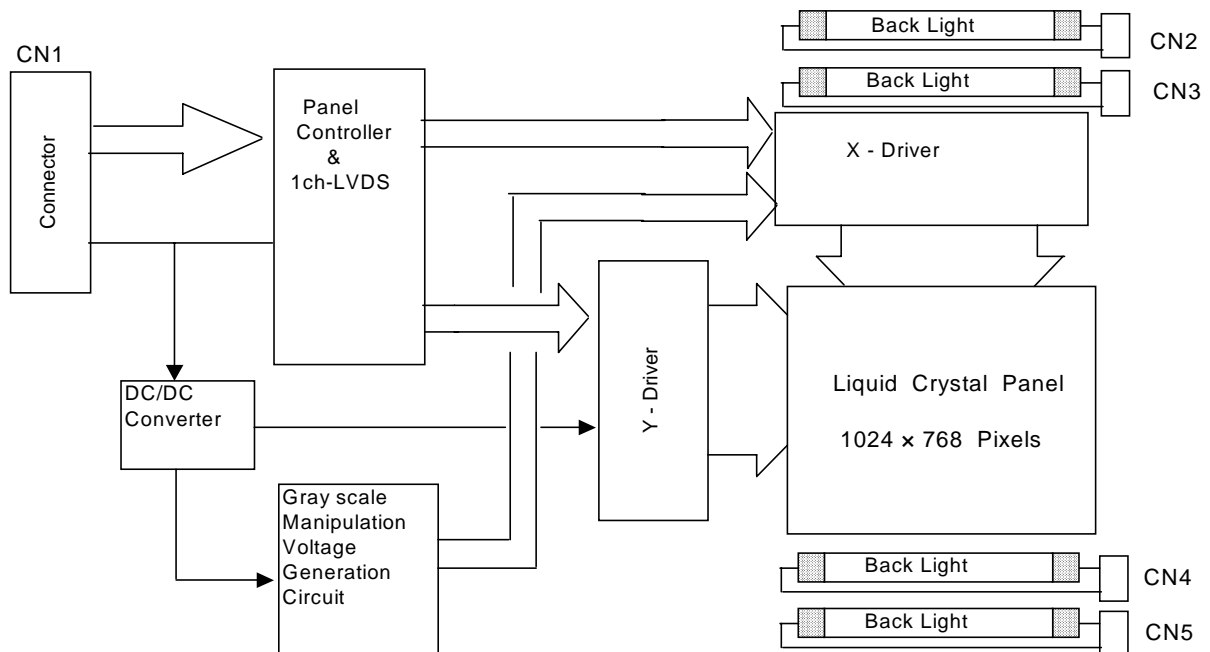## 2.3.2 Dimensional Outline

Unit : mm
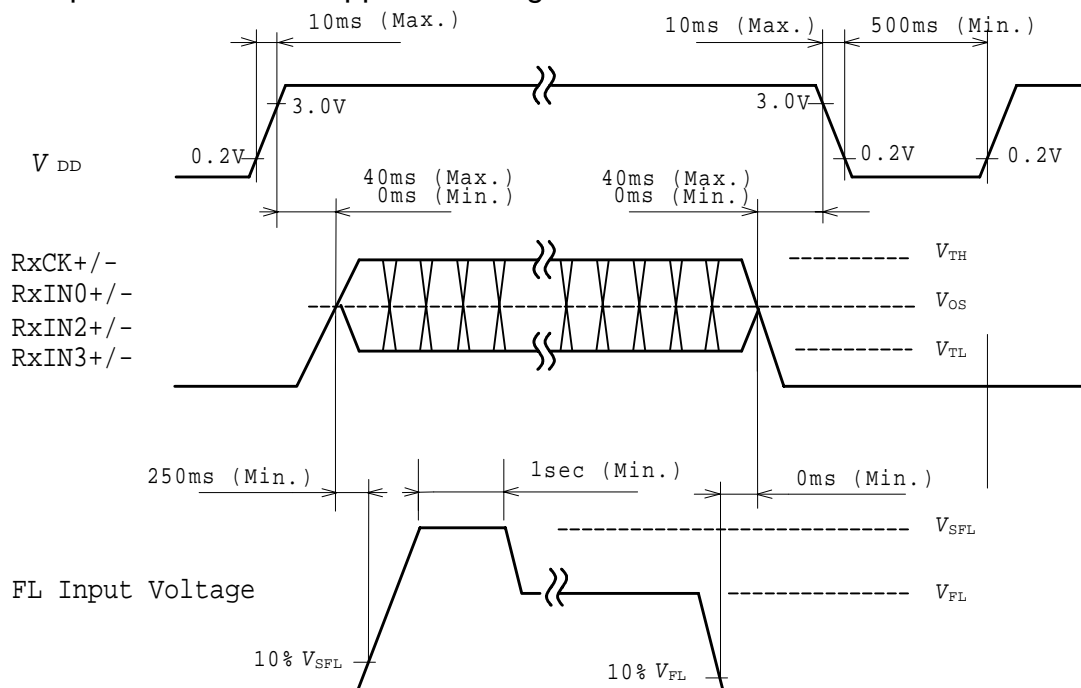
Standard Tolerance : 0.5

SECTION a-a'

2.4 Electrical Specifications
2.4.1 Circuit Diagram

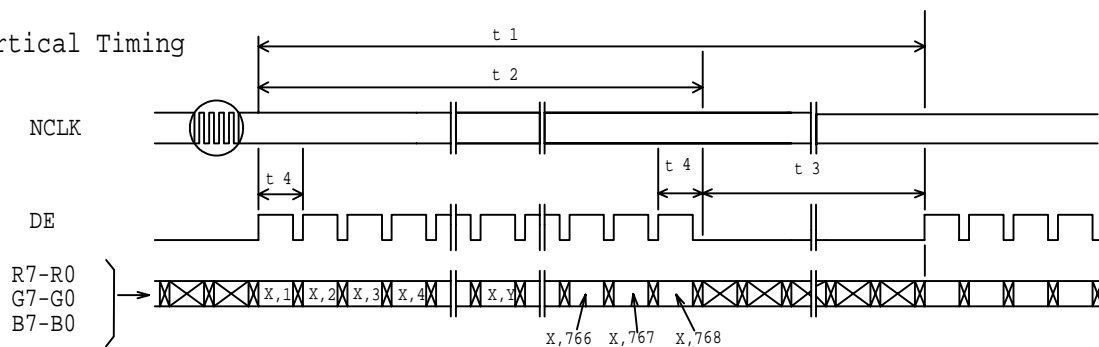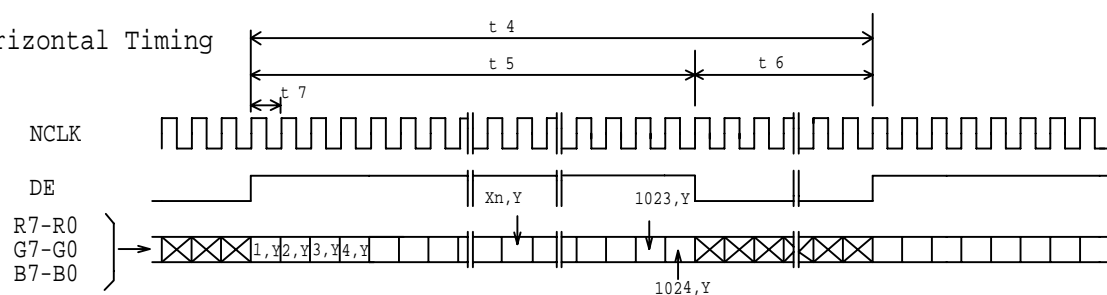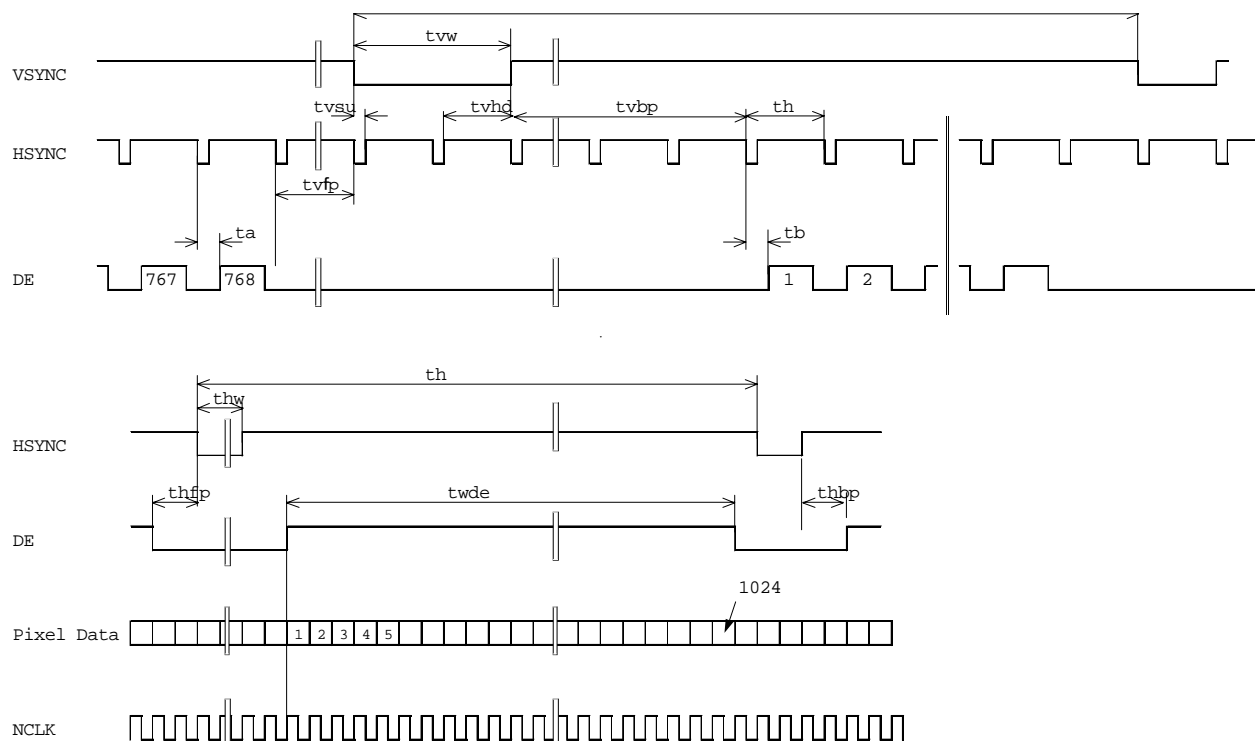### 2.4.2 Sequence of Power Supplies and Signals

2.4.3 Timing Chart

(1) Vertical Timing

(2) Horizontal Timing

(3) Vertical / Horizontal Sync Timing

2.4.4 Timing Specifications [1) 2) 3) 4)]

Item	Symbol	min.	typ.	max.	unit
Frame Period	t1	790 x t4	-	810 x t4	-
		13.245	-	16.75	ms
Vertical Display Term	t2	768 x t4	768 x t4	768 x t4	-
Vertical Blanking Term	t3	22 x t4	-	42 x t4	-
1 Line Scanning Time	t4	1090 x t7	-	1800 x t7	-
		15.80	-	28.34	us
Horizontal Display Term	t5	1024 x t7	1024 x t7	1024 x t7	-
Horizontal Blanking Term	t6	66 x t7	-	776 x t7	-
NCLK (Clock) Period	t7	12.500	-	15.748	ns
V-Sync Pulse Width	tvw	2 x t4	-	-	-
V-Sync Set up Time	tvsu	8 x t7	-	-	-
V-Sync Hold Time	tvhd	thbp+16 x t7	-	-	-
Vertical Front Porch	tvfp	2 x t4	-	-	-
Vertical Back Porch	tvbp	6 x t4	-	-	-
Horizontal Period	th	1090 x t7	-	1800 x t7	-
		15.80		28.34	us
H-Sync Pulse Width	thw	8 x t7	-	-	-
Horizontal Front Porch	thfp	4 x t7	-	500 x t7	-
Horizontal Back Porch	thbp	8 x t7	-	492 x t7	-
thw + thbp		16 x t7	-	500 x t7	
DE Pulse Width	twde	1024 x t7	1024 x t7	1024 x t7	-

$t3 = tvfp + tvw + tvbp$

$t4 = th$

$t6 = thfp + thw + thbp$

Note 1) Refer to " 2.4.4 Timing Chart" and LVDS (THC63LVDF84A) specifications by THine Electronic, Inc..

Note 2) If DE is fixed to "H" or "L" level for certain period while NCLK is supplied, the panel displays black with some flicker.

Note 3) If NCLK is fixed to "H" or "L" level for certain period while DE is supplied, the panel may be damaged.

Note 4) Please adjust LCD operating signal timing and FL driving frequency, to optimize the display quality.
There is a possibility that flicker is observed by the interference of LCD operating signal timing and FL driving condition (especially driving frequency), even if the condition satisfies above timing specifications and recommended operating conditions shown in 3.

Note5) Do not make $t1$, $t2$, t3 and $tvbp$ and $thbp$ fluctuate.
If $t1$, $t2$, $t3$ and $tvbp$ and $thbp$ are fluctuate, the panel displays error.

Note6) In case of using the long frame period, the deterioration of display quality, noise etc. may be occurred.

Note7) NCLK count of each Horizontal Scanning Time should be always the same.
V-Blanking period should be "n" X "Horizontal Scanning Time". (n: integer)
Frame period should be always the same.

2.4.5 Interface Connector

CN1   INPUT SIGNAL
        Connector: DF14A-20P-1.25H   / HIROSE
        Mating Connector: DF14-20S-1.25C   / HIROSE

Terminal No.	Symbol	Function
1	V_{DD}	Power Supply: +3.3V
2	V_{DD}	Power Supply: +3.3V
3	GND	
4	GND	
5	RXIN0-	Transmission Data of Pixels 0 (Negative: -)
6	RXIN0+	Transmission Data of Pixels 0 (Positive: +)
7	GND	
8	RXIN1-	Transmission Data of Pixels 1 (Negative: -)
9	RXIN1+	Transmission Data of Pixels 1 (Positive: +)
10	GND	
11	RXIN2-	Transmission Data of Pixels 2 (Negative: -)
12	RXIN2+	Transmission Data of Pixels 2 (Positive: +)
13	GND	
14	RXCK-	Sampling Clock (Negative: -)
15	RXCK+	Sampling Clock (Positive: +)
16	GND	
17	RXIN3-	Transmission Data of Pixels 3 (Negative: -)
18	RXIN3+	Transmission Data of Pixels 3 (Positive: +)
19	GND	
20	NC	(Toshiba Internal Terminal)

Note) NC Terminal should be open.

CN2, 3, 4, 5   CCFL POWER SOURCE
        Connector: BHSR-02VR-1 / JAPAN SOLDERLESS TERMINAL MFG CO., LTD.
        Mating Connector: SM02B-BHSS-1 / JAPAN SOLDERLESS TERMINAL MFG CO., LTD.

Terminal No.	Symbol	Function
1	V_{FLH}	CCFL Power Supply (high voltage)
2	V_{FLL}	CCFL Power Supply (low voltage)

2.4.6 Recommended Transmitter Interface Assignment

Signal Interface					
Input Terminal		Input Signal(Graphics controller output signal)		Output Signal	To LTM15C458
Number	Symbol	Symbol	Function	Symbol	Interface Terminal:Symbol
51	T1IN0	R0	RED pixels DISPLAY DATA (LSB)	T1OUT0- T1OUT0+	5
52	T1IN1	R1	RED pixels DISPLAY DATA		6
54	T1IN2	R2	RED pixels DISPLAY DATA		
55	T1IN3	R3	RED pixels DISPLAY DATA		
56	T1IN4	R4	RED pixels DISPLAY DATA		
3	T1IN6	R5	RED pixels DISPLAY DATA		
4	T1IN7	G0	GREEN pixels DISPLAY DATA (LSB)		
6	T1IN8	G1	GREEN pixels DISPLAY DATA	T1OUT1- T1OUT1+	8
7	T1IN9	G2	GREEN pixels DISPLAY DATA		9
11	T1IN12	G3	GREEN pixels DISPLAY DATA		
12	T1IN13	G4	GREEN pixels DISPLAY DATA		
14	T1IN14	G5	GREEN pixels DISPLAY DATA		
15	T1IN15	B0	BLUE pixels DISPLAY DATA (LSB)		
19	T1IN18	B1	BLUE pixels DISPLAY DATA		
20	T1IN19	B2	BLUE pixels DISPLAY DATA	T1OUT2- T1OUT2+	11
22	T1IN20	B3	BLUE pixels DISPLAY DATA		12
23	T1IN21	B4	BLUE pixels DISPLAY DATA		
24	T1IN22	B5	BLUE pixels DISPLAY DATA		
27	T1IN24	Hsync	Horizontal Synchronization Signal		
28	T1IN25	Vsync	Vertical Synchronization Signal		
30	T1IN26	ENAB	Data Enable Signal		
50	T1IN27	R6	RED pixels DISPLAY DATA	T1OUT3- T1OUT3+	17
2	T1IN5	R7	RED pixels DISPLAY DATA (MSB)		18
8	T1IN10	G6	GREEN pixels DISPLAY DATA		
10	T1IN11	G7	GREEN pixels DISPLAY DATA (MSB)		
16	T1IN16	B6	BLUE pixels DISPLAY DATA		
18	T1IN17	B7	BLUE pixels DISPLAY DATA (MSB)		
25	T1IN23	GND	1)		
31	T1CLK IN	NCLK	DATA SAMPLING CLOCK	T1CLK OUT- T1CLK OUT+	14 15

Type No. of transmitters (made by THine or National Semiconductor Corporation)
THC63LVDM83A/DS90C*385* series

TOSHIBA

2.4.7 Colors Combination Table

	Display	R7 R6 R5 R4 R3 R2 R1 R0	G7 G6 G5 G4 G3 G2 G1 G0	B7 B6 B5 B4 B3 B2 B1 B0	Gray Scale Level
Basic Color	Black	L L L L L L L L	L L L L L L L L	L L L L L L L L	–
	Blue	L L L L L L L L	L L L L L L L L	H H H H H H H H	–
	Green	L L L L L L L L	H H H H H H H H	L L L L L L L L	–
	Light Blue	L L L L L L L L	H H H H H H H H	H H H H H H H H	–
	Red	H H H H H H H H	L L L L L L L L	L L L L L L L L	–
	Purple	H H H H H H H H	L L L L L L L L	H H H H H H H H	–
	Yellow	H H H H H H H H	H H H H H H H H	L L L L L L L L	–
	White	H H H H H H H H	H H H H H H H H	H H H H H H H H	–
Gray Scale of Red	Black	L L L L L L L L	L L L L L L L L	L L L L L L L L	L 0
	Dark ↑ ↓ Light	L L L L L L L H	L L L L L L L L	L L L L L L L L	L 0
		L L L L L L H L	L L L L L L L L	L L L L L L L L	L 0
		L L L L L L H H	L L L L L L L L	L L L L L L L L	L 0
		L L L L L H L L	L L L L L L L L	L L L L L L L L	L 4
		:	:	:	L5… L252
		H H H H H H L H	L L L L L L L L	L L L L L L L L	L253
		H H H H H H L L	L L L L L L L L	L L L L L L L L	L254
	Red	H H H H H H H H	L L L L L L L L	L L L L L L L L	Red L255
Gray Scale of Green	Black	L L L L L L L L	L L L L L L L L	L L L L L L L L	L 0
	Dark ↑ ↓ Light	L L L L L L L L	L L L L L L L H	L L L L L L L L	L 0
		L L L L L L L L	L L L L L L H L	L L L L L L L L	L 0
		L L L L L L L L	L L L L L L H H	L L L L L L L L	L 0
		L L L L L L L L	L L L L L H L L	L L L L L L L L	L 4
		:	:	:	L5… L252
		L L L L L L L L	H H H H H H L H	L L L L L L L L	L253
		L L L L L L L L	H H H H H H L L	L L L L L L L L	L254
	Green	L L L L L L L L	H H H H H H H H	L L L L L L L L	Green L255
Gray Scale of Blue	Black	L L L L L L L L	L L L L L L L L	L L L L L L L L	L 0
	Dark ↑ ↓ Light	L L L L L L L L	L L L L L L L L	L L L L L L L H	L 0
		L L L L L L L L	L L L L L L L L	L L L L L L H L	L 0
		L L L L L L L L	L L L L L L L L	L L L L L L H H	L 0
		L L L L L L L L	L L L L L L L L	L L L L L H L L	L 4
		:	:	:	L5… L252
		L L L L L L L L	L L L L L L L L	H H H H H H L H	L243
		L L L L L L L L	L L L L L L L L	H H H H H H L L	L254
	Blue	L L L L L L L L	L L L L L L L L	H H H H H H H H	Blue L255
Gray Scale of White & Black	Black	L L L L L L L L	L L L L L L L L	L L L L L L L L	L 0
	Dark ↑ ↓ Light	L L L L L L L H	L L L L L L L H	L L L L L L L H	L 0
		L L L L L L H L	L L L L L L H L	L L L L L L H L	L 0
		L L L L L L H H	L L L L L L H H	L L L L L L H H	L 0
		L L L L L H L L	L L L L L H L L	L L L L L H L L	L 4
		:	:	:	L5… L252
		H H H H H H L H	H H H H H H L H	H H H H H H L H	L253
		H H H H H H L L	H H H H H H L L	H H H H H H L L	L254
	White	H H H H H H H H	H H H H H H H H	H H H H H H H H	White L255

Note1 L: Low level voltage, H: High level voltage

3. Recommended Operating Conditions [1]

Item	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply Voltage	V_{DD}	3.0	3.3	3.6	V	[2]
"H" Level Input	V_{IH}	2.0	-	V_{DD}	V	
"L" Level Input	V_{IL}	GND	-	0.8	V	
Differential Input High Threshold	V_{TH}	-	-	$(V_{OS})+0.1$	V	V_{OS}=1.2V [3] (V_{OS}: Offset Mode Voltage)
Differential Input Low Threshold	V_{TL}	$(V_{OS})-0.1$	-	-	V	V_{OS}=1.2V [3] (V_{OS}: Offset Mode Voltage)
FL Input Current per Lamp	I_{FL}	3.0	-	6.0	mA(rms)	[7] [8] [9]
FL Driving Voltage	V_{FL}	-	690	-	V(rms)	I_{FL}=6.0mA(rms) / Lamp [9]
FL Driving Frequency	f_{FL}	30	50	80	kHz	[9]
FL Starting Voltage	V_{SFL}	1440	-	2000	V(rms)	0℃ [9]

Note 1) The module should be always operated within these ranges. The "Typ." shows the recommendable value.

Note 2) Checked Pin Terminal : V_{DD} , GND   (GND : Vss = 0V)

Note 3) Checked Pin Terminal : R1IN0-,R1IN0+,R1IN1-,R1IN2-,R1IN2+,R1IN3-,R1IN3-,GND   (GND : Vss = 0V)

Note 4) Recommended LVDS transmitter : THC63LVDM83A (Thine) or DS90C*385* series   (National Semiconductor Corp.)

Note 5) This TFT-LCD module conforms to LVDS standard (TIA/EIA-644).
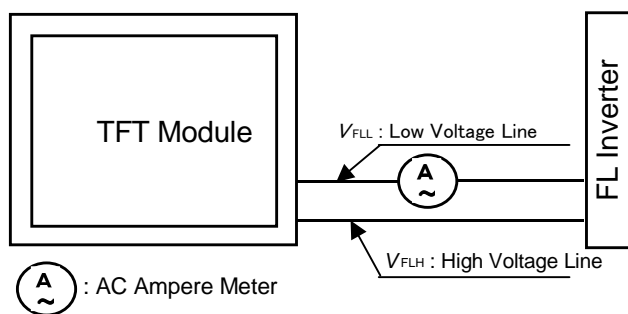
Note 6) Refer to LVDS specifications.

Note 7) Checked Pin Terminal : V_{FLH}-V_{FLL}

Note 8) If FL input current is higher than typical value, then FL lifetime become shorter.

Note 9) Measuring Method of I_{FL} :

    This TFT-LCD module uses twin FL lamps.

    So the measuring value of AC ampere meter is FL input currents of two lamps.

Note10) Please adjust LCD operating signal timing and FL driving frequency, to optimize the display quality.

    There is a possibility that flicker is observed by the interference of LCD operating signal timing and FL driving frequency, even if the condition satisfies above recommended operating condition and timing specification shown in 2.4.4

Note 11) Input FL starting voltage (V_{SFL}) should not be less than one second.

    If it were less than one second, it may cause unstable operation of FL.

4. Electrical Characteristics

4.1 Test Conditions

Ambient Temperature　　　: T_a　　25±5°C

Ambient Humidity　　　　: H_a　　65±20%(RH)

Supply Voltage　　　　　: V_{DD}　　3.3V

Input Signal　　　　: XGA@60Hz (VESA-Standard)

Signal Mode	Vertical			Horizontal			*NCLK* (*t7*) [ns]	Note
	FV (*t1*) [ms]	*V-TOTAL* [Line]	*V-DISP* [Line]	*FH* (*t4*) [us]	*H-TOTAL* [NCLK]	*ENAB* (*H-DISP*) [NCLK]		
XGA@60Hz　(VESA)	16.66	806	768	20.68	1344	1024	15.38	VESA-Standard

FL Inverter　　　　　　　:　Modified VNR15C423S-INV

FL Input Current　　　　: I_{FL}　　6.0mA(rms) / Lamp

FL Driving Frequency　　: f_{FL}　　50kHz

4.2 Specifications

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Current Consumption	I_{DD}	-	350	500	mA	V_{DD} Terminal Current

Note 1) The Typical value of I_{DD} is measured in the following pattern.

1. White
2. Yellow
3. Purple
4. Red
5. Light Blue
6. Green
7. Blue
8. Black

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

5. Optical Characteristics

5.1 Test Conditions

It is same as 4.1

The measuring method is shown in 11.

5.2 Optical Specifications

Item		Symbol	Conditions		Specifications			Unit	Remark
					Min.	Typ	Max.		
Viewing Angle		θ	CR>=10	$\phi=$ 180°	60	(80)	-	°	1)
				$\phi=$ 0°	50	(70)	-	°	$V0$=4.2V
				$\phi=$ 90°	65	(80)	-	°	
				$\phi=$ -90°	65	(80)	-	°	
Contrast Ratio		CR	θ=0°, ϕ=0°		300	450	-	-	$V0$=4.2V
Response Time		t_r	θ=0°, ϕ=0°		-	6	20	ms	
		t_f			-	19	50	ms	
Luminance		L	θ=0°, ϕ=0° Gray Scale Level=L255 (White)		300	(350)	-	cd/m^2	
Luminance Uniformity		LUNF	θ=0°, ϕ=0° Gray Scale Level=L255 (White)		-	-	20	%	
Chromaticity	Red	xR	Gray Scale Level:L255		0.616	0.646	0.676	-	
		yR	θ=0°, ϕ=0°		0.309	0.339	0.369	-	
	Green	xG	Ditto		0.241	0.271	0.301	-	
		yG			0.574	0.604	0.634	-	
	Blue	xB	Ditto		0.111	0.141	0.171	-	
		yB			0.050	0.080	0.110	-	
	White	xW	Ditto		0.283	0.313	0.343	-	
		yW			0.299	0.329	0.359	-	

Note 1): Refer to "11. Measuring Method".

Note 2) Photometer : BM-5A TOPCON (Aperture 2°)

Note 3): The above test limit must be applied for initial use.　Characteristics will be shifted by long period operation, but it is not irregular phenomena.　Theoretically brightness characteristics will be decreased due to CCFL degradation and color shift due to optical components change.

TOSHIBA CORPORATION **LIQUID CRYSTAL DISPLAY DIVISION**	Date:2001-10-29　New No.NR-LTM15C458-11 Date:　　　　　　Old　No.

←#　Special　　←&　Addition　　←　Change

6.Quality

6.1 Inspection AQL

Total of Major Defects   : AQL 0.65 %

Total of Minor Defects   : AQL 1.5 %

Sampling Method   : ANSI/ASQC Z1.4 (Level 2)

6.2 Test Conditions

1) Ambient Temperature   : 25±5°C

2) Ambient   Humidity   : 65±20%（RH）

3) Illumination   : Approximately 500 lx under the fluorescent lamp

4) Viewing Distance   : Approximately 30cm by the eyes of the inspector from the module

5) Inspection Angle   : θ=0°, ϕ=0°

6.3 Dimensional Outline

The products shall conform to the dimensions specified in 2.3.2.

Definition of Major and Minor defects are as follows.

Item	Description	Class
Important Dimensions	Dimensional outline, Dimensional between the mounting holes.	Major
Others	Dimensions specified in this specifications	Minor

6.4 Appearance Test

6.4.1 Test Conditions

1) Condition : Non-operating : PCB Appearance, Soldering, Bezel, Plastic Frame, Connectors

    Same as 6.2

2) Condition : Non-operating and operating : Black and White Spots/Lines

    Same as 6.2

6.4.2 Specifications

Item	Description	Class
PCB Appearance	Pattern peeling snapping, electrically short	Major
	Repair portion on PCB is not covered by epoxy resign	Minor
Soldering	Cold solder joint, lead move when pulled	Major
Bezel, Frame, Connectors	Distinct stain, rust or scratch	Minor
Black and White Spots/Lines[1][2]	(see tables below)	Minor

Line width (mm)	Length (mm)	Acceptable count
$W \leqq 0.05$	-	neglect
$0.05 < W \leqq 0.07$	$L \leqq 3$	$n \leqq 8$
$0.07 < W \leqq 0.10$		$n \leqq 2$
$0.10 < W$		[2]

Average diameter(mm)	Acceptable count/side
$D \leqq 0.2$	neglect
$0.2 < D \leqq 0.3$	$n \leqq 5$
$0.3 < D \leqq 0.5$	$n \leqq 2$
$0.5 < D$	0

Note 1) Inspection area should be within viewing area.

Note 2) Dusts which are bigger not less than 0.10mm ($0.1 \leqq W$) shall be judged by "Average Diameter".

Average Diameter $D = (a+b)/2$ (mm)
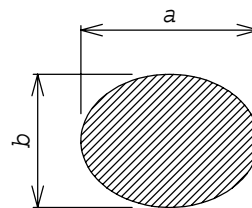
6.5 Display Quality

6.5.1 Test Conditions

1) Inspection Area : Within viewing area

2) Condition   : Same as test conditions shown in 4.1 and 6.2

3) Test Pattern   : White display pattern (gray scale level L255) , Black display pattern (gray scale level L0)

                    Red display pattern (gray scale level L255), Green display pattern (gray scale level L255)

                    Blue display pattern (gray scale level L255)

6.5.2 Specifications [4]

Item	Description / Specifications	Class
Function	No display, Malfunction	Major
Display Quality [1)2)3)]	Missing line	Major
	Missing Sub-Pixels	Minor
	1) Bright defects : 0 pcs. maximum [2)3)4)]	
	2) Dark defects : 3 pcs maximum [2)4)]	
	3) Total sub-pixel defects : 3 pcs maximum [4)]	
	4) Dark defect conjunction (2sub-pixels) : 0set	
	5) Dark defect conjunction (3sub-pixels) : 0set	
	6)Distance : Dark defect – Dark defect $\geqq$ 5mm	
	Inconspicuous flicker, crosstalk, Newton's ring and other defects : neglect [5)6)]	-
Black and White Spots/line	Same as 6.4.2 [6)]	Minor
Backlight	Missing (Non-operating)	Major

Note 1) Defects of both color filter and black matrix are counted as bright or dark defects.

         Inspection area should be within the active area.

Note 2) Bright defect means a bright spot (sub-pixel) on the display pattern of gray scale L0.

         Dark defect means a dark spot (sub-pixel) on the display pattern of gray scale L255.

Note 3) Bright spot which can not be found by using 5%ND-Filter shall not be counted as a defect.

Note 4) Defect conjunction is counted as 1 defect.

Note 5) Test pattern : White and black 1dot-checker display pattern (gray scale level L255 and L0),

Note 6) Test Pattern : White display pattern (gray scale level L127), Black display pattern (gray scale level L0)

6.6 Reliability Test
6.6.1 Test Conditions

1) The module should be driven and inspected under normal test conditions.

2) The module should not have condensation of water (moisture) on the module.

3) The module should be inspected after two or more hours storage in normal conditions (15 - 35°C, 45 - 65%(RH)).

4) A module shall be used only for one test.

6.6.2 Specifications

The module shall have no failure in the following reliability test items.

Test Item	Test Conditions	Result
High Temperature Operation [1]	50°C 192 h	OK 3p/3p
High Temperature Storage [2]	60°C 192 h	OK 3p/3p
High Temperature High Humidity operation [1]	50°C 80% 192 h	OK 3p/3p
Low Temperature Operation [1]	0°C 192 h	OK 3p/3p
Low Temperature Storage [2]	-20°C 192 h	OK 3p/3p

Temperature Shock [2]	-20°C ⇔ 60°C
	  0.5h 0.5 h
	                50 cycles
		OK 3p/3p

Mechanical Vibration [2]	10 - 200 - 10Hz sweep/cycle, $1.5 \times 9.8 m/s^2$ constant, X.Y.Z each directions, 0.5h each	OK 3p/3p
Mechanical Shock [2]	$50 \times 9.8 m/s^2$, 20ms, ±X, ±Y, ±Z direction, one time each	OK 3p/3p

Note 1) Operating
Note 2) Non-Operating

Definitions of failure for judgment shall be as follows:

1) Function of the module should be maintained.

2) Current consumption should be smaller than the specified value.

3) Appearance and display quality should not have distinguished degradation.

4) Luminance should be larger than 50% of the minimum value. (Refer to 5.2 Optical Specifications)

6.7 Labels
(1) Product Label

unit: mm

Serial number : △△ ▲ 1A 0 00001
                ① ② ③ ④ ⑤

① : Module type code

② : Manufacturing code
     C: MADE IN JAPAN
     W: MADE IN TAIWAN

③ : Lot code   1   A
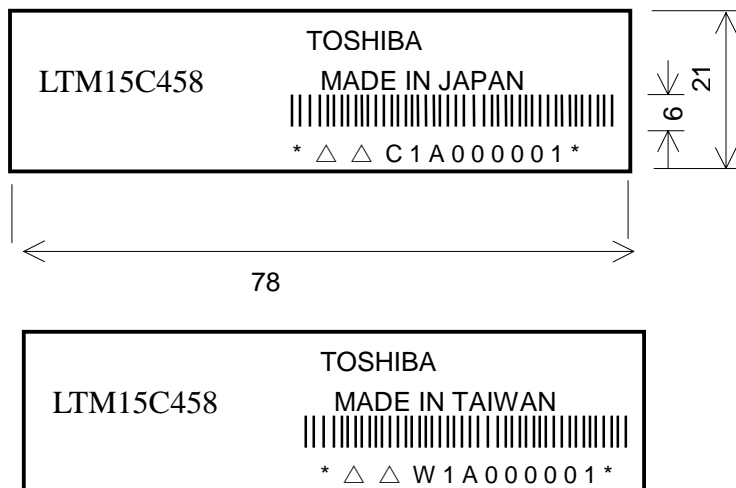   (1) (2)
     (1):Year code-end of the A. D.
     (2):Month code-alphabet
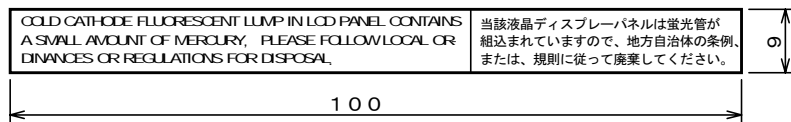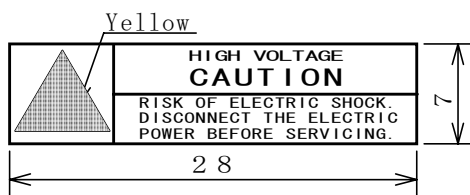   →Jan. : A - Dec. : L

④ : Revision No.

⑤ : Serial code   decimal, 5 figures

```
TOSHIBA
LTM15C458    MADE IN JAPAN
             ||||||||||||||||||||
             * △ △ C 1 A 0 0 0 0 0 1 *
```
21 / 6
78

```
TOSHIBA
LTM15C458    MADE IN TAIWAN
             ||||||||||||||||||||
             * △ △ W 1 A 0 0 0 0 0 1 *
```

(2) Caution Labels

• High Voltage

Yellow
```
HIGH VOLTAGE
  CAUTION
RISK OF ELECTRIC SHOCK.
DISCONNECT THE ELECTRIC
POWER BEFORE SERVICING.
```
7
28

• Disposal of CCFL
```
COLD CATHODE FLUORESCENT LUMP IN LCD PANEL CONTAINS
A SMALL AMOUNT OF MERCURY, PLEASE FOLLOW LOCAL OR
DINANCES OR REGULATIONS FOR DISPOSAL.
```
当該液晶ディスプレーパネルは蛍光管が組込まれていますので、地方自治体の条例、または、規則に従って廃棄してください。
9
100

(3) Label Locations

Disposal of CCFL Label
Caution Label
B/L Sirial Label
Product Label
PRODUCT LABEL
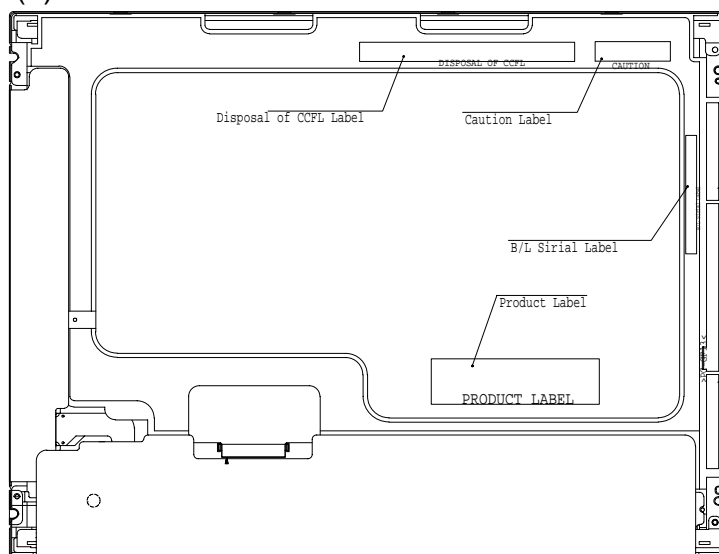
7. Lifetime

7.1 Module (include lamp)

MTBF (Mean Time Between Failure) : 25,000 h

(This value is not assurance time but inference value by following conditions.)

Definitions of failure for judgment shall be as follows.

1) LCD luminance becomes half of the minimum value.

2) Lamp doesn't light normally
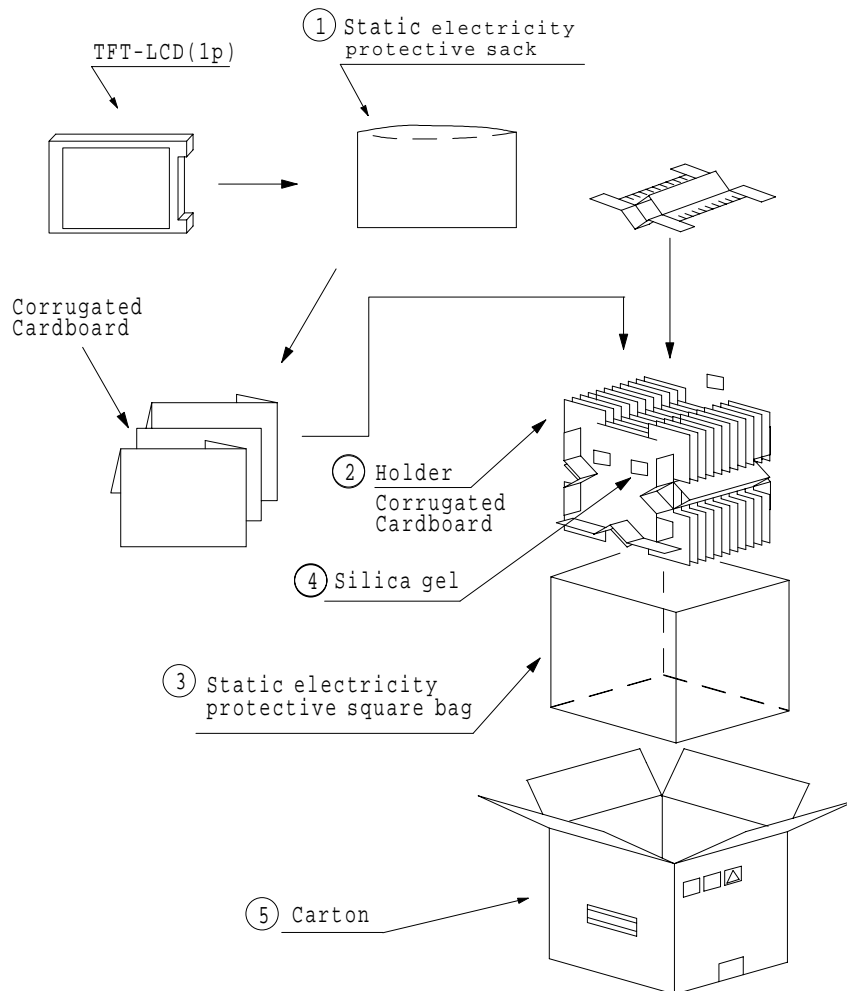
7.2 Test Conditions

Conditions : Ambient temperature　: 25±5°C (No wind)

Ambient humidity　　: 65%(RH)

Lamp current　　　 : 6.0mA(rms) / Lamp

Lighting condition　 : continuous lighting

8. Packaging
8.1 Carton (internal package)
#### (1) Packaging Form
Corrugated cardboard box

(2) Packaging Method [1) 2)]   :

Note 1) : Total weight   : (Approx.)   16kg
Note 2) : Acceptable number of piling   :   9 sets

(3) Packaging Material   :

Number	Quantity	Description
①	10	Static electricity Protective sack
②	1 set	Holder(inner box)
③	1	Static electric Protective square bag
④	3	Silicagel(50g×3)
⑤	1 set	Carton
⑥		Plastics adhesive tape

←# Special   ←& Addition   ← Change
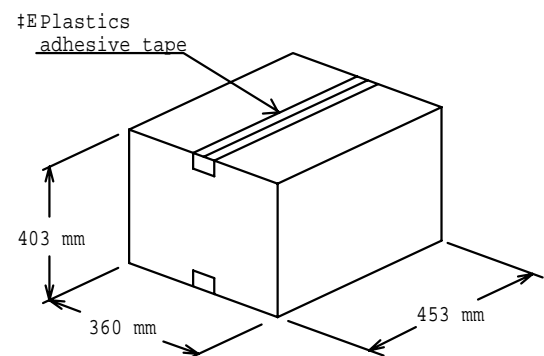
9. Warranty

Warranty clause will be decided separately.

10. Regulation

The set (which our LCD module is assembled into) to conform the regulations below, take measures in set side. Toshiba is not liable for the regulations to the complete set, nor can guarantee our LCD module conform the regulation by itself.

a) Examples of EMI Regulations

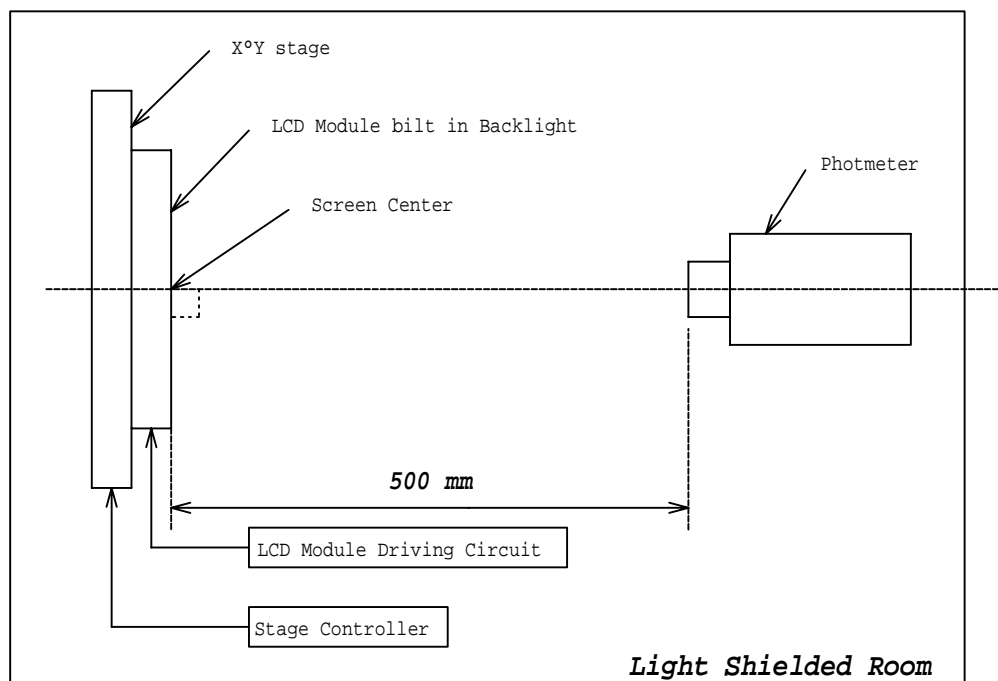FCC　　　: PART15　CLASS B
VCCI　　 : CLASS B
CISPR　　: CLASS B

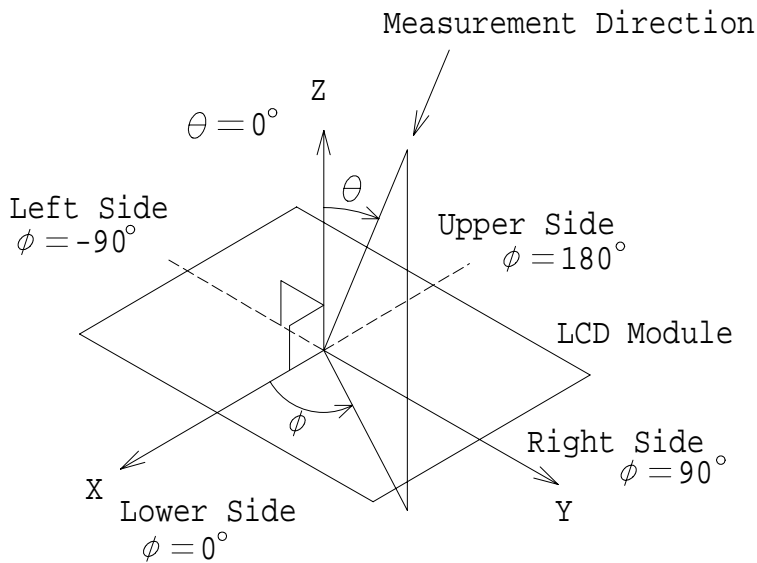b) Examples of Safety Regulations

IEC 950
UL 1950

11. Measuring　Method
11.1 Measuring System

(1) The measurement point is the center of the active area except the measurement of Luminance Uniformity.

(2) Photometer : BM-7/BM-5A TOPCON (Aperture 2°)

(3) Definition of φ and θ :

Measurement Direction

$$\theta = 0°$$

Z

θ

Left Side
$$\phi = -90°$$

Upper Side
$$\phi = 180°$$

LCD Module

φ

Right Side
$$\phi = 90°$$

X

Lower Side
$$\phi = 0°$$

Y

11.2 Measuring Methods

(1) Luminance:

The luminance of the center on a white raster (gray scale level L255) shall be measured.

Measurement shall be executed 30 minutes after the lamp is lit up.

(2) Contrast Ratio:

The contrast ratio can be calculated by the following expression.

Contrast Ratio (CR) = L255 / L0

L255 : Luminance on the white raster (gray scale level L255)

L 0 : Luminance on the black raster (gray scale level L0)

(3) Viewing Angle

Viewing angle is defined as the angles(θ, ϕ), in which specified contrast ratio can be obtained.

(Refer to 11.1(3) for the axes.)

(4) Luminance Uniformity:

    The Luminance should be measured at 9 positions on white raster(gray scale level L255).

    Uniformity can be calculated by the following expression.

$$\text{Luminance Uniformity} = \frac{|\text{ Maximum or Minimum Luminance} - \text{Average Luminance }|}{\text{Average Luminance of 9 Point}} \times 100\%$$

Horizontal Line Number [Pixel]
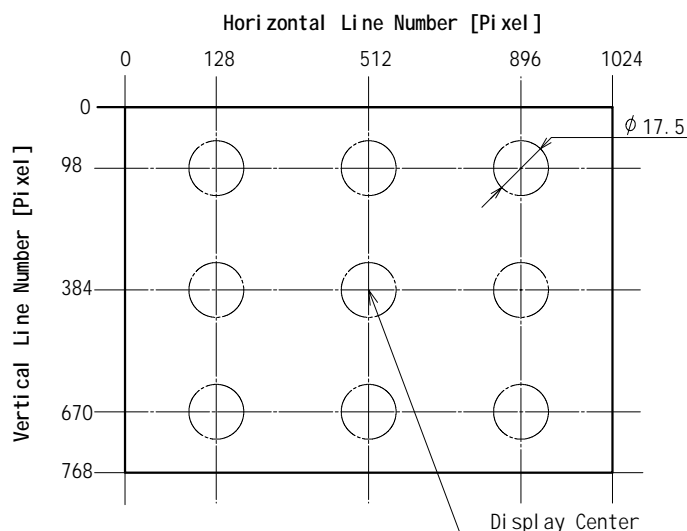
(5) Chromaticity :

    The values(x,y) of chromaticity coordinates should be measured for the White, Red, Green and Blue Raster(gray scale level L255) each with a photometer.

(6) Response Time :

    The response time is measured using a photo detector (photodiode) which measures the light intensity of the pixels.

Input Signal :   All High   All Low   All High

    (White Display)   (Black Display)   (White Display)
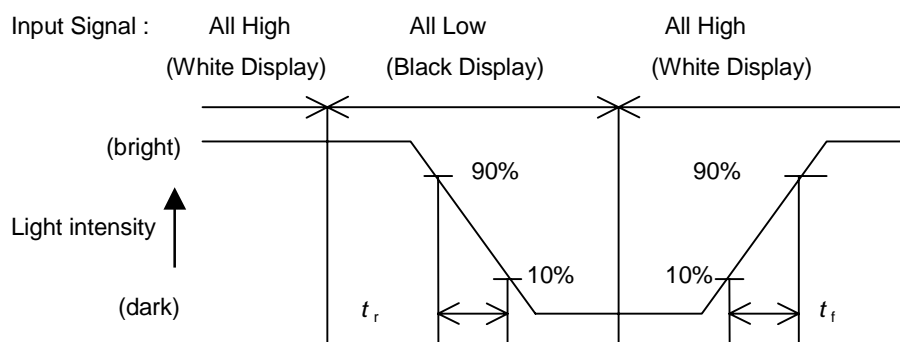
t_f : Fall time is the time for the light intensity of the pixels to go from 10% of its maximum to 90% of its maximum.

t_r : Raise time is the time for the light intensity of the pixels to go from 90% of its maximum to 10% of its maximum.

Photodiode   : S1223-01 HAMAMATSU PHOTONICS K.K.

White Display : White Raster (gray scale level L255)

Black Display : Black Raster (gray scale level L0)

12. Safety Documents

If ECN issues for this module, Toshiba notifies the changes to Samsung Electronics Company.

Toshiba proceeds ECN procedure after receiving approval of Samsung Electronics Company.

For Samsung Electronics Company's reference, Toshiba provides the parts list to Samsung Electronics Company every three months.

12.1 Parts List approved by UL

The module has been used the components in the list.

Item No.	Component Part	Generic Name	Manufacture	Type No.	UL File No.	Frame Class
#1	Plastic Frame (Material)	PC	Sumitomo Dow LTD.	ST5131V FR	E123529	94V-2
#2	X-PCB	FR-4	NCI Electronics Co., ltd	TW10794V-0	E46872	94V-0
#3	Y-PCB	FR-4	NCI Electronics Co., ltd	TW10794V-0	E46872	94V-0
#4	Connector 1 (Material) (CN1: I/F connector)	PA	Hirose Electric Co., ltd UBE Industries ltd.	DF14H-20P-1.25H 8020SG8	--- E48133	--- 94V-0
#5	Connector 2 (CN2: FL connector)		Japan Solderless Terminal MFG Co., ltd	BHSR-02VS-1	E60389	94V-0
#6	Connector 3 (Material) (For FPC)	LCP PPS	Hirose Electric Co., ltd Sumitomo Chemical Co., ltd Dainippon Ink & Chemicals Inc.	FH17-20S-0.5SH E6008MR B E6008LHF B FZ-1140-D4	--- E54705 E54705 E53829	--- 94V-0 94V-0 94V-0
#7	FPC	PI	Career Tech (MFG) Co., ltd.	B	E153087	94V-0
#8	FL Cable (HOT) (GND)	Silicone	Nissei Electric Co., ltd Kurabe Industrial Co., ltd. Sumitomo Electric Industries ltd.	UL3570 AWG24 UL3570 AWG24 UL3443 LF	E56198 E46702 E41105	VW-1 VW-1 VW-1
#9	Insulation Sheet	PET AI	Toray Industries Inc. Sumitomo 3M ltd.	Lumirror S AL-50BT	E86511 E59505	94VTM-2 ---
#10	Insulation Seal	PET	Teraoka Seisakusyo Co., ltd	630F #25	E56086	UL510FR
#11	Spacer (material)	Silicone	Shin-Etsu Chemical Co., ltd Dow Corning Toray Silicone Co., ltd	SS-50 SH851U	--- E55519	--- 94HB
---	Polarizer	---	Nitto denko Corp.	---	---	---
---	Liquid Crystal	---	Chisso Petrochemical Corp.	---	---	---
---	Color Filter	---	Toppan Printing Co., ltd.	---	---	---
---	Array	--- ---	TFPD Corp. HannStar Display Co., ltd	--- ---	--- ---	--- ---
---	Fluorescent Lamp	--- ---	West Electric Co., ltd Harison Toshiba Lighting Co., ltd	K-CT310-26-**** HBTM24J****310 NLU/*****	--- ---	--- ---
---	FL Reflector	SUS+Ag	Mitsui Chemicals,Inc.	MT-02-SUS430(E)H	---	---
---	X-Driver IC	---	NEC Corp.	uPD16732DN-129	---	---
---	Y-Driver IC	---	Toshiba Corp. Matsushita Electric Industrial Co., ltd.	T6L52 MN863561GPR1	--- ---	--- ---

Bezel

#11 Spacer

X-TAB (8p)

#4 I/F Connector

Cell

#6 Connector

#2 X-PCB

#7 FPC

#11 Spacer

#3 Y-PCB

#5 FL Connector

Y-TAB (3p)

#8 FL Cable

#11 Spacer

#5 FL Connector

#8 FL Cable

#1 Plastic Frame

#9 Insulation Sheet

#9 Insulation Sheet

Screw

Screw

Screw

Screw

←# Special 　←& Addition 　← Change